Refractory-grade graphite

How healthy is supply?

Simon Moores,
Manager, Industrial Minerals Data, London, UK
Overview

• Supply
  • Leading flake graphite suppliers
  • China, Brazil, India, North Korea, Canada

• Prices
  • All time highs attracts new entrants

• Demand
  • New competition from electric vehicles

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Supply

Unstructured carbons
- Natural

Graphite
- Natural and synthetic

Nano carbons
- Generally synthetic

Diamond
- Natural and synthetic

Coke
- Coal
- Anthracite

Petroleum coke

Regular Needle

Regular Needle

Pitch coke

Synthetic
- Primary
- Secondary

Amorphous

Flake
- Vein

Expandable

Spherical

Graphene

Nanotubes

Fullerenes

Graphene

Refactory grade graphite
- Flake
- > 85% Carbon
- >100 mesh

Source: Adapted by Industrial Minerals Research from Superior Graphite

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Simon Moores, Manager, Industrial Minerals Data, smoores@indmin.com
How healthy is refractory graphite supply?

Global flake graphite producers and trends 2010 v 2011

<table>
<thead>
<tr>
<th>Rank</th>
<th>Supplier</th>
<th>Production (tpa)</th>
<th>Production trend 2010/2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>China</td>
<td>380,000</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Brazil</td>
<td>96,000</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>India</td>
<td>35,000</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>North Korea</td>
<td>30,000</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Canada</td>
<td>21,000</td>
<td></td>
</tr>
</tbody>
</table>

*Other: ~21,000 tonnes*

Source: Natural Graphite Report 2012, Industrial Minerals Research

**Key:**
- **Green Up**
- **Red Down**
- **Yellow Stable**
- **Blue Intermittent**

Source: Industrial Minerals Research

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China – How healthy is refractory graphite supply?

#1
World production rank

77%
World graphite supply share
(flake + amorphous + vein)

67%
World flake graphite supply share

Source: Natural Graphite Report 2012, Industrial Minerals Research

Qingdao Haida Graphite, Shandong, China

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China – largest supplier, industry in need of modernising, in sights of the government

- Direct supply restrictions
  - Capping of amorphous output
  - VAT on exports
  - Export tax

- In-direct supply restrictions
  - Controlling its sprawling mining industry
  - Controlling pollution
  - Becoming more efficient with use of resources / resource protection

Qingdao Haida Graphite, Shandong, China

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Brazil – How healthy is refractory graphite supply?

#2
World production rank

9%
World graphite supply share
(flake + amorphous + vein)

16%
World flake graphite supply share

Source: Natural Graphite Report 2012, Industrial Minerals Research

Nacional de Grafite, Minas Gerais, Brazil

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Brazil – **healthy, vibrant, increasing output**

- Home to world’s largest non-Chinese producer, Nacional de Grafite
- Only country increasing flake output 2010-2012
- Very expensive for Brazilian producers to export, domestic focus

Nacional de Grafite, Pedra Azul mine, Minas Gerais, Brazil

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India – How healthy is refractory graphite supply?

#3
World production rank

3%
World graphite supply share
(flake + amorphous + vein)

6%
World flake graphite supply share

Source: Natural Graphite Report 2012, Industrial Minerals Research

Shruti Salwan, Industrial Minerals Data, flanked by Tirupati Carbons & Graphite

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India – small producers, fragmented, domestically orientated

• 100% flake producer

• Production hugely over estimated for years
  • 35,000 tpa not 140,000 tpa

• Industry very fragmented, Consolidation needed

• No exports

• Overhaul needed to be a big export player

Tirupati Carbons & Graphite, Radba mine, Jharkhand state, India

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North Korea – How healthy is refractory graphite supply?

#4

World production rank

3%

World graphite supply share
(flake + amorphous + vein)

5%

World flake graphite supply share

Source: Natural Graphite Report 2012, Industrial Minerals Research

Supreme Leader, Kim Jong-Un

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North Korea – Captive supply for China, major production issues

• Former j-v mine with South Korea
• 100% captive supply for China
• Major production problems including energy and water availability
• Still a large produce despite problems – 30,000 tpa

Rail cargo crossing the divide between North and South Korea (AP, 2007)

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Canada— How healthy is refractory graphite supply?

#5 World production rank

2% World graphite supply share (flake + amorphous + vein)

4% World flake graphite supply share

Lac-des-Iles mine, Timcal (Imerys SA), Canada’s major producer

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Canada – **Dwindling supply, changing of mines, surge in new exploration**

Brightest new graphite mine prospects in Canada

- Existing supply dwindling
  - Lac-des-Iles an old mine, Timcal switching to new mines in 2012 / 2013

- Exploration boom 2011-2012
  - Graphite the new hot mineral for investors, league as lithium and rare earths

- Only a handful of bright prospects

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Why the interest in graphite? Prices + uses

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Why the interest in graphite? Prices + uses

Uses – Electric vehicle batteries

- Graphite (natural + synthetic) the anode of choice for all battery technologies

- Spherical graphite = the goal
  - Highly processed flake graphite
  - Optimum product for batteries

- 2.5 tonnes of flake graphite = 1 tonne of spherical graphite

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EVs charging in central London, August 2012
Warning: Batteries compete directly with refractories for the same flake graphite

Nissan LEAF = 24 kWh battery = 38.5kg graphite
1m. EVs = 105,000 tonnes graphite = medium to large flake = 5 new mines

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Concluding points

• Existing Supply is not healthy

• Most countries are struggling to increase production

• China dominates supply = eagerness to reduce dependence

• Refractory producers starting to focus on captive supply – Magnesita Refratarios

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**Bloomberg**

Magnesita Jumps on New Graphite Plant License: Sao Paulo Mover

14th September 2012

“There is a scarcity in the case of graphite it is clearly not a reliable supply chain. Any company that is in this industry that is serious about being in business has to find a solution to their raw materials outside of China,”

Flavio Barbosa, CFO, Magnesita Refractarios

July 2011

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Data, analysis and forecast for the next five years

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- Unique country supply reviews including: China, Brazil, India, North Korea, and Canada
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- How will prices react? Historical analysis and forecast
- Demand risks
- Critique of the graphene revolution

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